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A comparative evaluation of marginal bone loss around the implants placed by Osseo densification and conventional implant osteotomy- An invivo study

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Abstract

Background: Osseodensification (OD) is the latest technique of biomechanical bone preparation performed for dental implant placement. Standard drills excavate bone during implant osteotomy, whereas Densah burs allow for bone preservation and condensation through compaction autografting during osteotomy preparation, thereby increasing the bone density in the peri-implant areas and improving the implant mechanical stability. The aim of this study is to assess the marginal bone loss around implants placed using conventional burs and osseodensification burs.

Methods: A total of 30 implantswere placedin 8 patients in mandibular posterior region and were randomly divided into two groups with 15 sites in each group**.** Test group – Patients were subjected to implant placement by osseodensification osteotomy Control group – Patients were subjected to implant placement by conventional osteotomy**.**Crestal bone level assessment was done radiographically atbaseline and 3months.Statistical analysis was done using unpaired t test for inter group crestal bone loss**.**

Result: The mean marginal bone loss for the test and control groups was 0.30 ± 0.32 and 1.43 ± 0.37 respectively. The mean bone loss was higher in the control group than the test group which was statistically significant (p value < 0.05).

Conclusion: osseodensification burs can be used as an alternative to conventional burs for osteotomy preparation.

Keywords: osseodensification, osteotomy, crestal bone loss.

Introduction

Implant placement for replacing missing teeth has gained enormous popularity as a more dependable treatment option. The implant success depends on the osseointegration. The concept of osseointegration is developed by Dr. P I Branemark and his colleagues in 1952 and had defined it as a "direct structural and functional connection between the ordered living bone and the surface of load-carrying implant."[1] The osseointegration of implant relies on factors such as: bone density, surgical drilling protocol, implant surface texture, implant geometry, and primary and secondary stability.[2] Thus it can be understood that the technique used for osteotomy preparation is also considered as major factor affecting the osseointegration.[3]To overcome the limitations of conventional osteotomy technique, other techniques such as osteotome technique, piezoelectric surgery, hard tissue lasers, sinus augmentation, bone grafting ridge expansion, undersized implant osteotomy preparation, Implant surface modifications, drug-based modification and addition of biological factors have been introduced.[4]With the advent and introduction of osseodensification by VERSAH (Densah) burs, which combine the advantages of conventional drill speed, tactile sensation, and osteotome techniques,[5] the limitation of conventional osteotome technique could be decreased. The osseodensification technique is believed to increase the primary stability and bone volume % (BV %) and bone to implant contact (BIC).[6] This facilitated by non-subtractive drilling procedure and compaction auto-grafting within the osteotomy site.[7]Surgical trauma and bone density are two key factors affecting the marginal bone loss around implants postoperatively.[8] Thus, the present study aims to assess the marginal bone loss around implants placed using conventional burs and osseodensification burs.

Materials and methods

The study was conducted on selected patients who reported to the Department of Periodontics and Implantology, Drs.Sudha and NageswaraRao Siddhartha Institute of Dental Sciences. A total of 8 patients with 30 edentulous sites in the mandibular posterior region with ages ranging from 25 to 65 years were enrolled in this study. The institutional ethical committee approved the study. Treatment procedure was explained to all the patients and written informed consent was obtained. The duration was about three months, and the patients were randomly divided into two groups with 15 sites in each group. The patients were selected based on the following criteria.

Inclusion criteria

1) Patient aged between 25 – 65 years

2) Patients with bilaterally missing teeth in the mandibular posterior region.

3) Presence of adequate bone height (≥10 mm) and width (≥5 mm)

4) A minimum distance of 2 mm to the adjacent anatomical structures (Mandibular canal, mental foramen, floor of the maxillary sinus and adjacent teeth)

Exclusion criteria

1) Patients with uncontrolled systemic diseases

2) Pregnant and lactating women

3) Patients with a habit of smoking

4) Patients with bleeding disorders (blood dyscrasias)

5) Patients with poor oral hygiene and untreated periodontal disease

Surgical procedure

All the implants were placed in a two-stage protocol. After achieving adequate local anesthesia at the implant site, crestal incision was given and full-thickness mucoperiosteal flap was elevated. Osteotomy site preparation was done using conventional drills in the control group and the length and diameter were prepared to the pre-planned measurements in the CBCT in both the groups. In the test group, the osseodensification drills are used in the following manner. Initial pilot drill is used in clockwise direction to drill to the desired depth. Depending upon the implant type and diameter selected for the site, begin with the narrowest Densah bur in reverse direction. (counterclockwise drill speed 800-1500 rpm with copious irrigation). When strong resistance is felt, change the drill motor to forward - cutting mode (clockwise direction at 800-1500 rpm with copious irrigation). Begin advancing the Densah bur into the osteotomy until reaching the desired depth. Without removing the bur, change the drill motor back to reverse direction (counterclockwise drill speed 800-1500 rpm with copious irrigation) inorder to densify and autograft the cut bone back onto the osteotomy walls (densifying mode). By not removing the bur from the osteotomy between cutting and densifying modes, the cut bone particles are deposited within the osteotomy. After completion of the osteotomy site preparation implant of preferred size is placed into it and were covered with cover screws. Flaps were approximated with simple interrupted sutures. All the patients were prescribed with Amoxicillin + Clavulanic acid 625mg twice daily for 5 days, Ibuprofen 400mg twice daily for 5 days along with 0.2% chlorhexidine mouth rinse twice daily until complete oral hygiene habits were resumed. Patients were advised not to brush on the operated site for a week and other postoperative instructions were given and recalled after one week for suture removal.

Crestal bone levels

The amount of bone loss was assessed radiographically using standard intra-oral periapical radiographs along with the grid. Radiographs were taken at baseline and three months post-operatively. Crestal bone levels were measured at mesial and distal implant surfaces and averaged to yield mean marginal bone loss for that implant. Each implant shoulder is identified in the radiograph and was used as a reference point because all the implants were installed at the level of the bone crest. At baseline, measurements were recorded by calculating the radio-opaque squares from the implant shoulder to the apex of the implant (reference point), and at three months, the crestal bone levels were evaluated by calculating the radio-opaque squares from the first bone-implant contact to the apex of the implant. The result obtained by subtracting the radio-opaque squares at three months from the radio-opaque squares at baseline signifies the crestal bone loss.

Statistical Analysis

Patient's demographic data were assessed using descriptive statistics. Comparison of implant length, implant width, crestal bone levels at 3 months interval were assessed using Independent t-test.

Results and discussion

A total of 30 implant osteotomy sites were prepared in 8 patients. All the 30 implants were loaded after 3 months.. Among these 15 implant sites were placed in the osteotomies prepared using conventional drills and 15 implants were placed by using osseodensification drills.

Table 1 depicts the demographic data. The test group enrolled 8 individuals out of which 2 were males and 6 were females. The distribution of males and females were similar in both the groups as the implants were placed on contralateral sites. Thus, the percentage of males was 25% and females were 75% and did not show any statistical significance between the groups (Table 1; Graph 1).

Table 2 depicts the mean age of test and control groups. The mean age in both the study groups was 42.20 ± 5.32. The results did not show any statistical significance between the groups (Table 2; Graph 2)

Table 3 shows the inter-group comparison between test and control with regard to implant diameter. The mean implant diameter for test and control group was 4.30 ± 0.44 and 4.20 ± 0.41 respectively with no statistical significance (Table 3; Graph 3). Table 5 shows comparison of mean marginal bone loss (MBL) between control and test group after 3 months of implant placement. The mean marginal bone loss for the test and control groups was 0.30 ± 0.32 and 1.43 ± 0.37 respectively. The mean bone loss was higher in the control group than the test group which was statistically significant (p value < 0.05). Higher amount of marginal bone loss around the implant shoulder was observed in control group when compared to the test group (Table 5; Graph 5).

Ever since the introduction of concept of osseointegration, implants have gained significant ground of interest in the field of dentistry. Among the various factors that influence the successful osseointegration of an implant, surgical instrumentation for osteotomy site preparation is the most important. The osteotomy preparation method will also affect the healing of bone after implant placement. Several surgical techniques have been implemented to increase Bone to Implant Contact and osseointegration like the use of osteotomes and undersized osteotomy preparation. The osteotome technique, which was introduced by Summer 1994[9] involved the compression and gradual expansion of the surrounding bone. This technique is mainly aimed to compact the bone with the mechanical action of cylindrical steel instruments along the walls of the osteotomy site and [10] .also causes ultra-structural micro-damage, further affecting the osseointegration. . Another technique used as an alternative to conventional drilling involved ridge expansion or spreading utilizing screw-type expanders, which caused osteotomy preparation but with displacement of bone (Corte and Cortes 2010)[11]. A new technique for osteotomy preparation was introduced by Salah Huwais 2017[4], which included the osteotome technique combined with conventional drill speed and tactile feedback to the clinician. The Osseodensification method is a multi-stepped drilling process that preserves the bone bulk by compaction auto-grafting along the osteotomy walls. The design of the bur is different from that of the conventional drills as it is multi-fluted, and has four or more lands. During osteotomy preparation, the osseodensification burs produce a controlled plastic deformation of bone, which allows the expansion of a cylindrical osteotomy without excavating bone.`[12] These burs are designed in such a way that they progressively increase in diameter throughout the surgical procedure and are designed to be used with standard surgical engines. They can be used in both clockwise (Cutting mode) and counterclockwise (Densifying mode) directions at a drill speed of 800 – 1500 rpm.The conventional drills have a positive rake angle that facilitates cutting and extracting bone particles leaving no residue in the osteotomy site. The osseodensification bur is multi-fluted with negative rake angle by which a compact, dense layer of bone graft is adapted on to the osteotomy walls creating an implant lamina dura.[7]This densification process is more efficiently exerted in counter-clockwise direction compared to clockwise direction alone. Thus, for an ideal osteotomy preparation Densifying after Cut mode is employed, which is facilitated by initial clockwise (Cutting mode) drilling followed by counterclockwise (Densifying mode) drilling without removing the bur from the osteotomy site.

This densification process preserves bone bulk in two ways: compaction of cancellous bone due to visco-elastic and plastic deformation and compaction auto-grafting of bone particles along the length and at the apex of the osteotomy.[4]. Osseodensification occurs in a slow, incremental process that can be controlled by the clinician. During this process, the residual strain is created that causes compressive forces against implant, therefore increasing the Bone to Implant Contact (BIC). This further promotes the osteogenic activity by a mechano-biologic healing process. Some studies reported that there was an increase in primary stability and BIC in implants placed within the condensed bone which, lead to improved bone healing by increasing bone density and bone to implant contact.[4] Salah Huwais and Eric Meyer 2017[4] compared between osseodensification and conventional osteotomy preparation in terms of stability, bone mineral density, and % BIC. It was found that osseodensification decreased the duration of healing, preserved the bone bulk, and increased primary stability, and % BIC compared to the conventionally placed implants. The criteria for successful implant therapy includes median marginal bone loss of 0.5 mm during healing, followed by an annual bone loss of < 0.02 mm.[9], Pham et al. 1994[12] evaluated the mean rate of % of bone change during osseointegration and at loading period (6 - 12 months and 12 - 24 months). They observed a higher % of bone loss per month in the preloading period compared to the post-loading period in implants placed by conventional drilling. They also found that the bone loss was greater during 6 - 12 months compared to 12 – 24 months period. The previous studies on osseodensification were in animal studies and clinical case reports. The present study was performed to evaluate and compare the effect of osseodensificaton and conventional drilling protocols on marginal bone loss. The results of the present study revealed a mean marginal bone loss of 1.46 ± 0.30 for implants placed by using conventional drills and 0.30 ± 0.20 for implants placed using osseodensification burs. There was a significant difference between the marginal bone loss values between the groups (p-value <0.001). These results were in accordance with the studies conducted by Salah Huwais and Eric Meyer 2017[4], Bradley Lahens et al. 2016[15], Polo Trisi et al. 45 2016[5], Paula G.F.Pessoa De Oliveria 2018[7] on osseodensification. The osseodensification technique aimed at compaction auto-grafting and bone expansion by plastic deformation which resulted in increased preserved bone bulk, bone mineral density, and increased BIC. Thus, decreasing the crestal bone remodeling and improved healing compared to conventional drilling.

The limitations of the study are minimal sample size and short term follow-up period. Further long term studies should be carried out to assess the proper beneficial aspects of osseodensification osteotomy preparation.

Conclusion

Both the groups demonstrated bone loss at 3 months but, the bone loss was less in test group compared to the control group which was statistically significant.

Based on the results obtained it can be concluded that osseodensification burs can be used as an alternative to conventional burs for osteotomy preparation.

Within the limitations of the study, further longitudinal studies with inclusion of other parameters like bone density, ridge width before and after implant placement and their effect on osseointegration should be carried out.

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Legends Tables and Figures

Table 1: distribution of males and females in two study groups

Gender	Control group	%	Test group	%
Male	2	25.00	2	25.00
Female	6	75.00	6	75.00
Total	8	100.00	8	100.00

Table 2: comparison of control and test groups with mean age by independent t test

Groups	N	Mean	SD	SE	t-value	P-value
Control group	15	42.20	5.32	1.37	0.0000	1.0000
Test group	15	42.20	5.32	1.37		

Table 3: comparison of two study groups(test and control)with respect to dimensions of implant–diameter by independent t test

Groups	n	Mean	SD	SE	t-value	P-value
Control group	15	4.20	0.41	0.11	-0.1500	0.8818
Test group	15	4.30	0.44	0.11		

Table 4: comparison of two study groups(test and control)with respect to dimensions of implant–length by independent t test

Groups	n	Mean	SD	SE	t-value	P-value
Control group	15	11.37	0.90	0.23	-0.5561	0.5826
Test group	15	11.57	1.07	0.28		

Table 5: comparison of control and test groups with mean marginal bone loss(mbl) at 3 months by independent t test

Groups	n	Mean	SD	SE	t-value	P-value
Control group	15	1.43	0.37	0.10	8.9956	0.0001*

*p<0.05

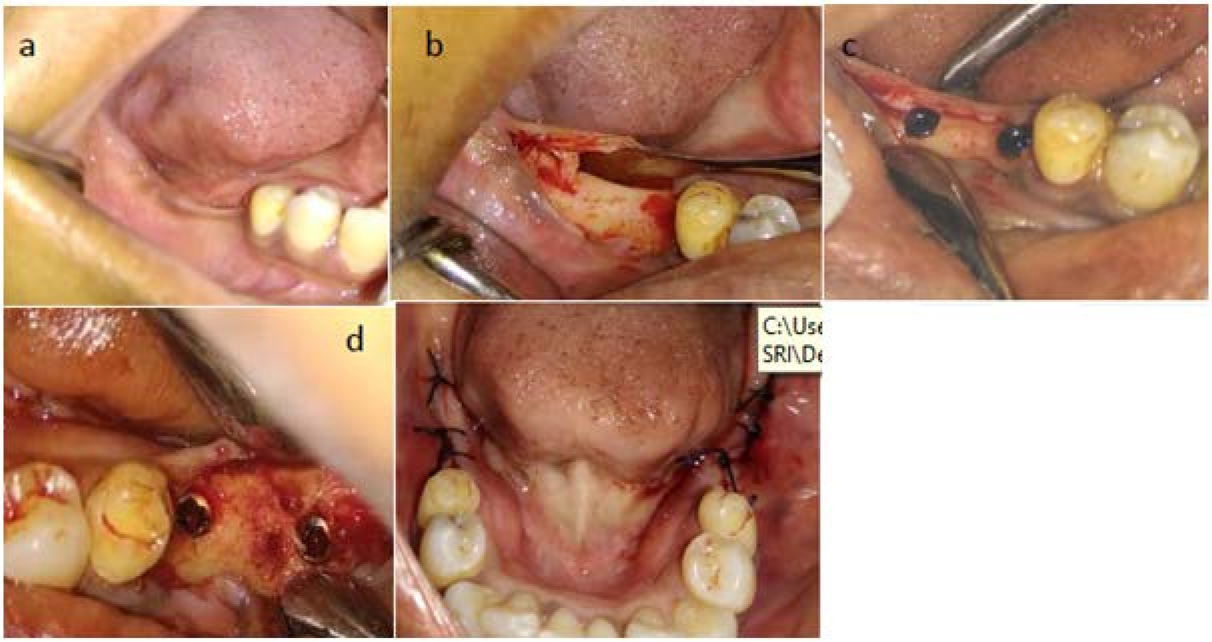

Fig 1: a) Pre-operative implant site , b) Flap reflection, c) Implants placed in test site 46,47, d) Implants placed in control site 36,37, e) Simple interrupted sutures placed**.**

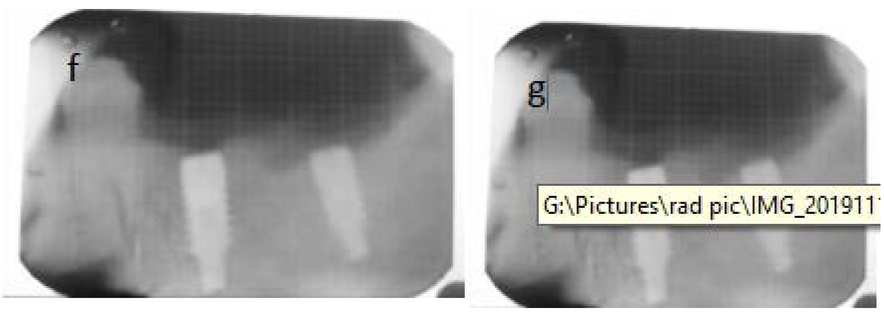

Fig 2: f - IOPA showing marginal bone level at baseline in test group, g – IOPA showing marginal bone level at 3 months in test group.